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HILL START ASSIST
[Sakamichi hasshin hojo souchi]

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1. Title of the Invention

Hill Start Assist

2. Claim

1. With respect to a device for retaining the braking force during takeoff on an upward slope, a hill start assist characterized by being equipped with an acceleration sensor for detecting the acceleration applied to the anteroposterior directions of the vehicle and for judging that the acceleration sensor is malfunctioning if the output of the acceleration sensor does not change for a predetermined period of time during the traveling of the vehicle.

3. Detailed Description of the Invention

[Industrial Field of the Invention]

The present invention relates to a hill start assist which is for retaining the braking force when starting a vehicle on an upward slope, specifically to a device suitably utilized for a vehicle equipped with a clutch controlled to contact and separate by means of a mechanical automatic transmission and an actuator.

[Outline of the Invention]

The respect to a device which detects the gradient of the road surface by means of an acceleration sensor for detecting the degree of acceleration

* Numbers in the margin indicate pagination in the foreign text.

applied to the anteroposterior directions of the vehicle and which also retains the braking force during takeoff on an upward slope, [the device of the invention] detects a failure by judging that the acceleration sensor is malfunctioning if the value of the output from the acceleration sensor does not change for a set amount of time during the traveling of the vehicle, and thereby surely detects the failure of the gradient sensor.

[Related Art of the Invention]

By equipping an automatic transmission, the burden on the driver driving the vehicle can be lightened. In other words, it becomes unnecessary to operate the gear shift lever or step on the clutch pedal in accordance with the traveling condition of the vehicle, and the driving operation becomes much easier. Moreover, since a gear shifting operation is not required, the driver can afford to pay more attention on the road, which improves the overall safety.

/242

A conventionally popular automatic transmission method is used in combination with a hydraulic clutch. Such a clutch transmits torques via a fluid and can, therefore, reduce shock, and it also has the advantage of improving the driving comfort. For this reason, it is widely used for vehicles.

However, an automatic transmission consisting of a hydraulic clutch is inefficient in terms of fuel consumption because of the sliding of the clutch, and it is, therefore, unsuitable for commercial vehicles. In light of this, it has been suggested to use mechanical automatic transmissions as the automatic transmissions of commercial vehicles. These

types of automatic transmissions are equipped with a shifting actuator as well as a selecting actuator, and a computer switches gears by operating these actuators in accordance with the vehicle condition. Moreover, such automatic transmissions are utilized in combination with a clutch which is controlled by the actuators to contact and separate.

[Problems that the Invention is to Solve]

Such a mechanical automatic transmission temporarily shuts off the clutch by means of the actuators during a gear change, and this shut-off operation is carried out uniformly. Therefore, it has a shortcoming in that the clutch connection is delayed during takeoff on an upward slope, causing the vehicle to move backward. To overcome this shortcoming, a hill start assist is combined so that the vehicle can take off on an upward slope while retaining the braking force.

Such a braking force retaining device, used in combination with a mechanical automatic transmission, detects the gradient of the road surface by means of an acceleration sensor, which is for detecting the degree of acceleration applied to the anteroposterior directions of the vehicle, and also retains the braking force during takeoff on an upward slope by means of the above-mentioned hill start assist. Moreover, a failure of the acceleration sensor, which is for detecting the gradient of the road surface, is detected when the output level is abnormal. This creates a problem in that failures of the gradient sensor cannot be detected reliably.

The invention was devised in light of the above problems, and its

aim is to supply a hill start assist that enables reliable detection of malfunctions of the acceleration sensor, which is for detecting whether or not the slope is uphill.

[Means for Solving the Problems]

With respect to a device for retaining the braking force during takeoff on an upward slope, the present invention is equipped with an acceleration sensor for detecting the acceleration applied to the anteroposterior directions of the vehicle and for judging that the acceleration sensor is malfunctioning if the output of the acceleration sensor does not change for a predetermined period of time during the traveling of the vehicle.

[Operation of the Invention]

Therefore, if the output of the acceleration sensor does not change for a predetermined time during the traveling of the vehicle, the acceleration sensor is judged as being malfunctioning, and the failure of the acceleration sensor is therefore detected.

[Embodiment of the Invention]

Figure 1 illustrates the hill start assist related to one embodiment of the invention, and this device is equipped with an air tank 10, which is used to store compressed air. The air tank 10 is connected to a braking pressure control valve 13 via a brake valve 12 equipped with a brake pedal 11. This brake pressure control valve 13 is connected to a pair of left

and right brake boosters 14. The above brake pressure control valve 13 is controlled by a computer 15. The input side of this computer 15 is connected to an acceleration sensor 16.

Furthermore, this hill start assist is designed to be used in combination with a mechanical automatic transmission 18. An upper part /243 of the transmission 18 is equipped with a shifting actuator 19 and a selecting actuator 20, and these actuators, 19 and 20, are operated based on signals from the computer 15 to switch gears. Moreover, this automatic transmission 18 is connected to a clutch 21, and the clutch 21 is controlled to contact or separate by means of a clutch actuator 22. The strokes of the clutch actuator 22 are detected by a stroke sensor 23. The above-mentioned transmission 18 is provided with a vehicle speed sensor 24, which is connected to the input side of the computer 15, and the output side of the computer 15 is connected to a warning lamp 25.

Next, the acceleration sensor 16 connected to the above computer 15 will be described. As illustrated in Figure 2 and Figure 3, this acceleration sensor is equipped with, when viewed from the side, a roughly square and flat container 26, and the internal space 27 of this container 26 is circular. One of the inner peripheries of this space 27 is provided with the formation of a circular common electrode 28, and the inner surface of the opposite side is provided with a pair of semicircular differential electrodes, 29 and 30, that face the common electrode 28. This space 27 has a dielectric fluid 31 sealed in it. The liquid level of this fluid 31 is roughly 1/2 of the height of the space 27.

Therefore, if acceleration is applied in the anteroposterior

directions of the acceleration sensor 16 and the liquid level of the dielectric fluid 31 tilts by θ as illustrated by the chain line in Figure 3, the capacity between the common electrode 28 and one of the differential electrodes 29 increases relatively with respect to the capacity between the common electrode 28 and the other differential electrode 30. Therefore, by differentially amplifying the electric capacity detected by the differential electrodes, 29 and 30, it is possible to obtain an output voltage that changes linearly in accordance with the tilt angle θ of the liquid level of the dielectric fluid 31 as illustrated in Figure 4. In other words, the acceleration applied in the anteroposterior directions of the vehicle can be extracted by the acceleration sensor 16 as a change in the voltage.

The computer 15 reads the output of the acceleration sensor 16 at the time of takeoff, and if posterior acceleration is detected by the acceleration sensor, it is determined that the road surface has an upward gradient. In other words, it is detected that a takeoff operation is being carried out on an upward slope, in which case the computer 15 retains the braking force of the brake booster 14 by controlling the brake pressure control valve 13.

The following is the concrete operation performed to retain a braking force. Compressed air from the air tank 10 illustrated in Figure 1 is supplied to the brake booster 14 via the brake valve 12 and brake pressure control valve 13, and in this condition, the brake pressure control valve 13 is closed in response to an instruction from the computer 15, and the operation of the brake booster 14 is thus maintained. Furthermore, the

computer 15 performs a normal control operation at this time based on the detection output of the acceleration sensor 16.

Moreover, this braking force retaining operation is carried out at the time of takeoff on an upward slope, and when the accelerator pedal is stepped on in an attempt to start the vehicle on the upward slope, the transmission 18 is shifted by the computer 15 to the takeoff gear position via the actuators, 19 and 20, and in this condition, the clutch 21 becomes connected by the actuator 22. Moreover, the connection of the clutch 21 is detected by the clutch stroke sensor 23, and if the clutch 21 is completely connected, the computer 15 releases the braking force retained by the brake pressure control valve 13. Therefore, the vehicle will not move backward during takeoff on an upward slope, and the retained braking force can be released at an appropriate timing. This makes it possible to perform a hill start smoothly without drawing out the brake.

Next, the operation for detecting a failure of the acceleration sensor 16, which is connected to the computer 15 and is for detecting the gradient of the road surface at the time of takeoff, will be described. As illustrated in Figure 5, the computer 15 determines whether the vehicle /244 has a speed by means of the vehicle speed sensor 24, and if the vehicle has a speed, that is to say if the vehicle is traveling, reads the output of the acceleration sensor 16. Moreover, it determines whether the output of this sensor is changing and, if the output is not changing, determines whether the condition lasts for a set amount of time. If the output of the acceleration sensor 16 does not change for the set amount of time, a malfunction is detected, and an alarm operation is carried out by means

of the warning lamp 25 or the like.

The acceleration sensor 16 also functions as the road-surface gradient sensor, and it even detects vibrations that are caused by the slightest unevenness of the road surface during the traveling of the vehicle. Therefore, if the acceleration sensor 16 is not abnormal, its output will inevitably change during the traveling of the vehicle. Therefore, the absence of such a change leads to the judgment that there is a failure, such as a broken wire. For example, if the output of the acceleration sensor 16 hardly changes for several seconds, it is judged that there is a failure, which is then appropriately alerted by means of the warning lamp 25. Therefore, this operation ensures the detection of failures of the acceleration sensor 16.

[Effects of the Invention]

As mentioned in the above, the present invention is designed to determine that the acceleration sensor is malfunctioning if the output of the acceleration sensor does not change for a predetermined amount of time during the traveling of the vehicle. Therefore, it is possible to surely detect failures of the acceleration sensor based on its own output.

4. Brief Description of the Drawings

Figure 1 is a block diagram showing the structure of the hill start assist related to one embodiment of the invention. Figure 2 is a vertical cross-sectional view of the acceleration sensor. Figure 3 is a

cross-sectional side view of the acceleration sensor. Figure 4 is a graph indicating the output characteristic of the acceleration sensor. Figure 5 is a flow chart indicating the failure detecting operation of the acceleration sensor.

The names of the essential parts of the drawings are as follows.

10 = air tank
11 = brake pedal
12 = brake valve
13 = brake pressure control valve
14 = brake booster
15 = computer
16 = acceleration sensor
18 = mechanical automatic transmission
19 = shifting actuator
20 = selecting actuator
21 = clutch
22 = clutch actuator
23 = clutch stroke sensor
24 = vehicle speed sensor
25 = warning lamp

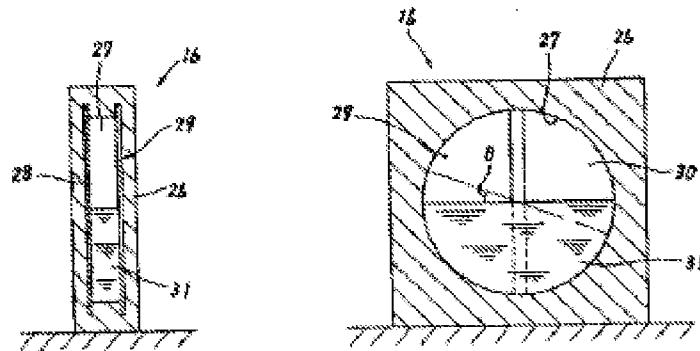


Fig. 2

Fig. 3

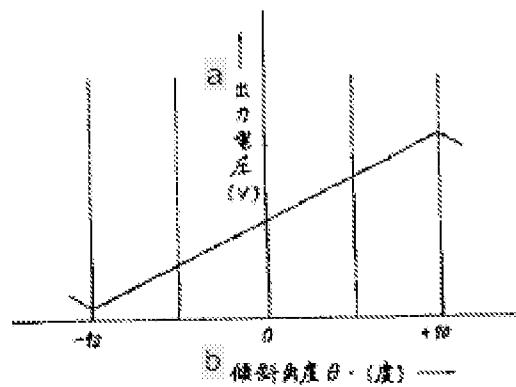


Fig. 4

Key: a) output voltage (V); b) tilt angle $\theta \cdot$ (degree).

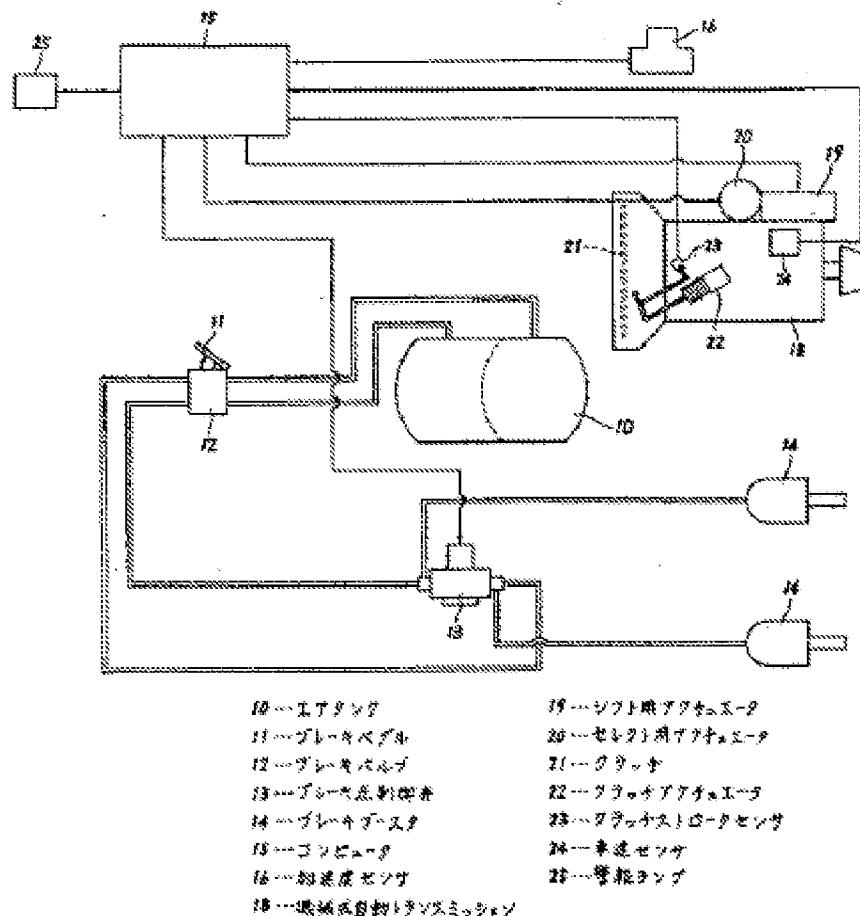


Fig. 1

Key: 10)air tank; 11)brake pedal; 12)brake valve; 13)brake pressure control valve; 14)brake booster; 15)computer; 16)acceleration sensor; 18)mechanical automatic transmission; 19)shifting actuator; 20)selecting actuator; 21)clutch; 22)clutch actuator; 23)clutch stroke sensor; 24)vehicle speed sensor; 25)warning lamp.

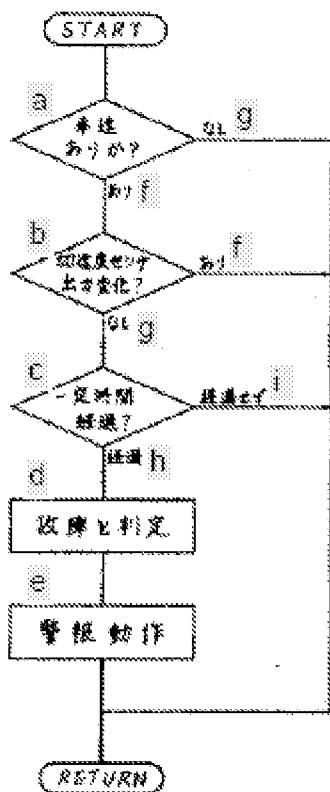


Fig. 5

Key: a) Does the vehicle have a speed?; b) Is there a change in the output of the acceleration sensor?; c) Has the set amount of time passed?; d) Detection of a failure is confirmed.; e) Warning operation is carried out.; f) yes; g) no; h) passed; i) not passed.